REPORT NUMBER: FEP-03-03

GLASGRID® PAVEMENT REINFORCEMENT PRODUCT EVALUATION

FINAL REPORT

APRIL 2003

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipients Catalog No.
FEP-03-03		

4. Title and Subtitle	5. Report Date
GlasGrid® Pavement Reinforcement Product Evaluation	April 2003
	6. Performing Organization Code WisDOT Research Study # WI-89-03
7. Author(s) Deb Bischoff, WisDOT Technology Advancement Engineer Amanda Toepel, WisDOT Technology Advancement Engineer	8. Performing Organization Report No. FEP-03-03
9. Performing Organization Name and Address Wisconsin Department of Transportation DTID/BHC, Technology Advancement Unit 3502 Kinsman Blvd., Madison, WI 53704-2507	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Wisconsin Department of Transportation Division of Transportation Infrastructure Development Bureau of Highway Construction Technology Advancement Unit 3502 Kinsman Blvd., Madison, WI 53704-2507	13. Type of Report and Period Covered Final Report 1990 - 2002 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This project was initiated in 1989 to evaluate the performance of GlasGrid®, a glass fiber mesh pavement reinforcement geotextile, in prohibiting or controlling the incidence of reflective cracking. In the summer of 1990, test sections examining two different types of the product, a single strand grid and a double strand grid, were constructed on STH 57 in Sheboygan County. After the existing joints and cracks of the PCC pavement, originally constructed in 1957, were cleaned and repaired, the project was overlayed with a 1½-inch lift of asphaltic concrete. The GlasGrid® was then installed in the test sections in 5-foot widths across the transverse joints and cracks of the underlying jointed Portland cement concrete pavement. With the GlasGrid® reinforcement in place, the final 1½-inch layer of the 3-inch asphaltic concrete overlay was placed over the entire project length.

Within six months, reflective cracks already appeared in the test sections. By the end of the fourth year, the percentage of reflective cracking that occurred in the double strand test sections surpassed that of the control sections, which had no GlasGrid®. The reflective cracks in the GlasGrid® test sections were mainly Type 3 (banded) cracks. The reflective cracks in the control section were Type 1 (less than ½ inch in width) cracks only, a much less severe crack than a Type 3.

Annual crack surveys were completed at the test site during the first five years and after ten years. A final field review was completed in April of 2002. The results of these surveys showed that both the single strand grid and double strand grid variations of the GlasGrid® product performed unsatisfactorily and were unable to prohibit or control reflective cracking effectively. Based on the results of this study, it is recommended that WisDOT not use GlasGrid® fiberglass mesh reinforcement as a method of reducing reflective cracking of an asphaltic concrete overlay or for extending the life of an asphaltic concrete overlay placed on a PCC pavement.

17. Key Words	18. Distribution Statement
GlasGrid, glass fiber, mesh, reflective cracking, single strand, double strand, product evaluation, pavement reinforcement, asphaltic overlay	Distribution Unlimited Authorized for Public Release

19. Security Classif. (of this report)	19. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	16	

GlasGrid® Pavement Reinforcement Product Evaluation

FINAL REPORT

WISCONSIN FEDERAL EXPERIMENTAL PROJECT # WI-89-03

FINAL REPORT #FEP-03-03

By:

Deb Bischoff, WisDOT Technology Advancement Engineer
Amanda Toepel, WisDOT Technology Advancement Engineer

APRIL 2003

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF TRANSPORTATION INFRASTRUCTURE DEVELOPMENT
BUREAU OF HIGHWAY CONSTRUCTION
PAVEMENTS SECTION
TECHNOLOGY ADVANCEMENT UNIT
3502 KINSMAN BLVD., MADISON, WI 53704 -2507

TABLE OF CONTENTS

INTRODUCTION

Reflective cracking is a problem that can develop in asphaltic overlays when they are placed over existing concrete or asphaltic concrete pavements. A reflective crack is formed when a joint or crack in the existing pavement propagates up into the asphaltic overlay. Eventually, the entire crack pattern of the underlying pavement will reflect up into the asphaltic overlay. The cracking results in a poor ride, increased maintenance costs, and a shorter pavement life. The vertical movement of the underlying pavement at the transverse joints or cracks and changes in temperature are two of the main causes of reflective cracking[1]. One method suggested to combat reflective cracking was the use of pavement reinforcing geotextiles. Many products of this type have been introduced in the market over the years. In 1989, the Wisconsin Department of Transportation (WisDOT) initiated a research study to evaluate the effectiveness of GlasGrid® pavement reinforcement in delaying or eliminating reflective cracking in asphaltic overlays placed on a Portland Cement Concrete (PCC) pavement.

PROJECT DESCRIPTION

In June of 1990, a rehabilitation project on State Trunk Highway (STH) 57, in Sheboygan County, Wisconsin, was selected as a test site for GlasGrid® pavement reinforcement. GlasGrid®, manufactured by Bayex, a division of Bay Mills Limited, is a self-adhesive glass fiber grid structure designed to prevent reflective cracking by dispersing crack development from the existing pavement through to the new surface. According to product literature, "the fiberglass grid is designed to turn crack stresses horizontally and dissipate the stress."[2] The test site was designed to evaluate two different types of GlasGrid® (see Figure 1 on next page). One of the types evaluated was the conventional grid with single strands on ½-inch centers. The other type was a double strand grid with double strands in the direction crossing the transverse joint or crack and single strands in the direction parallel to the transverse joint or crack, on the same ½-inch grid structure. A total of four test sections and two control sections were constructed for this research study.

[1] Hensley, Jay. "Get to the Bottom of Reflective Cracking Problems." <http://www.asphalt.com>. 2002.
[2] Saint-Gobain Technical Fabrics. "How GlasGrid Works." <http://www.glasgrid.com>. 2002.

Figure 1. **Product Information**

	GlasGrid Pavement Reinforcement Type	
	Single Strand Mesh (Type 8501)	**Double Strand Mesh (Type 8502)**
Tensile Strength* Across Width	560 lb./in.	1120 lb./in.
Tensile Strength* Across Length	560 lb./in.	560 lb./in.
Modulus of Elasticity	10,000,000 psi	10,000,000 psi

* based on component strand strength

The two main objectives of this study were to determine the effectiveness of the GlasGrid® pavement reinforcement at (1) reducing the amount of reflective cracking and (2) extending the life of an asphaltic overlay over a jointed reinforced PCC pavement.

PROJECT LOCATION

As illustrated in Figure 2 on page 11, the test sections were located on STH 57, a two-lane rural highway, between Plymouth and the north county line of Sheboygan County. More specifically, the test sections began just north of County Trunk Highway (CTH) J and continued north for 3700 feet. The existing PCC pavement, originally constructed in 1957, is a 9-inch reinforced PCC pavement over a 6-inch base course, over a 9-inch sand-gravel fill. The reinforcement of the 9-inch PCC pavement consists of wire mesh within the slabs and dowel bars at the joints that are spaced 80 feet apart. This roadway is a principal rural arterial, with an annual average daily traffic (AADT) of 3563 in 1990 and 5162 in 2001. The average AADT over that time frame was 4660. The average percentage of truck traffic over that same time frame was about 12%.

TEST SECTIONS

A total of four test sections and two control sections were constructed at the test site for evaluation purposes. Each section was 500 feet long and extended across the northbound and the southbound lane. Two of the test sections were constructed with the single strand

GlasGrid® and two more with the double strand GlasGrid®. Following, are the particulars of the test sections and control sections involved in this research study.

<u>Test Section 1A: Station 303+00 to 308+00, NB & SB</u>

1½-inch asphaltic concrete overlay

Double strand GlasGrid®

1½-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

<u>Test Section 2A: Station 308+00 to 313+00, NB & SB</u>

1½-inch asphaltic concrete overlay

Single strand GlasGrid®

1½-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

<u>Control Section 1A: Station 315+00 to 320+00, NB & SB</u>

3-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

<u>Test Section 1B: Station 323+00 to 328+00, NB & SB</u>

1½-inch asphaltic concrete overlay

Double strand GlasGrid®

1½-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

<u>Test Section 2B: Station 328+00 to 333+00, NB & SB</u>

1½-inch asphaltic concrete overlay

Single strand GlasGrid®

1½-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

<u>Control Section 1B: Station 335+00 to 340+00, NB & SB</u>

3-inch asphaltic concrete overlay

9-inch existing reinforced PCC pavement

6-inch existing base course

9-inch existing sand-gravel fill

CONSTRUCTION OBSERVATIONS

All joints and cracks of the existing PCC pavement (originally constructed in 1957) were cleaned and repaired prior to placing the overlay. Loose or spalled concrete and asphaltic patches were removed; and, joints and cracks were cleaned and filled with asphaltic mix. The initial construction plans and special provisions called for the GlasGrid® to be placed directly on the PCC pavement, centered over the joints and cracks. No tack coat was to be applied on the concrete pavement within the GlasGrid® test sections. Difficulties in keeping the grid in place were experienced during the early stages of the paving operations, as the tires of trucks lifted the fabric from the underlying pavement. Thus, the initial plan was altered to place the GlasGrid® between the binder and the surface courses of the asphaltic concrete overlay, rather than on the existing concrete pavement. The GlasGrid® that was already placed on the concrete was removed prior to paving the first lift.

The entire length of the project was to be resurfaced with 3 inches of a single aggregate gradation asphaltic concrete, placed in two lifts of 1½-inch each. After the existing PCC joints and cracks were cleaned and repaired, the entire length of the project was overlayed with the first 1½-inch layer of asphaltic concrete. The GlasGrid® was then installed in the test sections in 5-foot widths, the standard manufactured width, and centered over the joints and cracks. A rubber-tired roller was used to bond the self-adhesive GlasGrid® pavement reinforcement mesh to the clean and dry asphaltic concrete road surface. With the GlasGrid® positioned, the final 1½-inch layer of the 3-inch asphaltic concrete overlay was placed over the entire project length.

Minor difficulties were again experienced as the tires of the asphalt paver lifted the grid from the underlying binder course and slid the material, creating gaps that were later hand-filled. The crew was reminded that fuel oil was required to clean the tack coat (from adjacent areas) off the paver tires. As stated in the project's special provisions, "construction vehicles required to operate on the GlasGrid® treated area shall maintain tires free of tack coat from adjacent pavement areas." Once the tires were cleaned, no further problems were encountered.

PERFORMANCE EVALUATION

Crack survey data was used to evaluate the overall performance of each test section versus the control sections.

Since the use of the GlasGrid® pavement reinforcement was intended to reduce the amount of reflective cracking, the percentage or amount of reflective cracking was monitored. Thus, prior to construction, all cracks and joints in the existing concrete pavement were documented; and, each succeeding survey (after construction of the asphaltic overlay) compared the new cracks that had developed to the original number of cracks prior to the overlay. These crack counts (Table 1a, page 12) were used to calculate the percentages of reflective cracking (Table 1b, page 12). Since the pavements were monitored from the standpoint of overall performance, no attempt was made to distinguish between reflective cracking and fatigue cracking, with all cracks being considered reflective cracks.

Annual crack surveys were conducted for the first five years after the test sections were constructed. A final crack survey was also conducted ten years after construction. The field reviews showed cracking to be the only noteworthy form of distress present in the test sections or control sections.

The percentages of reflective cracking for each test section, are shown separately for the northbound and southbound lanes (see Tables 2a and 2b, on page 13). Tables 3a and 3b, on page 14, show the *average* percentages of reflective cracking of the different test sections in the northbound and southbound lanes. While Table 2a doesn't show any clear trend as to the best or worst performer in the northbound lanes over the first two years, the data does show that by the third year, the double strand GlasGrid® test sections showed the highest percentage of reflective cracking. Table 3a shows that the average percentage of reflective cracking of the different test sections in the northbound lanes was the highest in the single strand sections after one year in service, and highest in the double strand sections thereafter.

Table 2b indicates that the southbound control sections showed higher percentages of reflective cracking than the adjacent test sections in the southbound lanes over the first three years. The fourth and fifth year data of the different test sections in the southbound lanes show no particular performance trends. Table 3b shows that the average percentage of reflective cracking of the different test sections in the northbound lanes was the highest in the control sections for the first four years.

Table 4, shown on page 14, displays the average percentage of reflective cracking of the three different test sections, without distinguishing between the northbound and southbound lanes. Overall, the control sections showed the highest percentage of reflective cracking over the first three years. The double strand test sections showed the highest percentage of reflective cracking after the fourth and fifth years.

By the fifth year, an average of 87% of reflective cracking was visible in all the test sections. Sometime between the fifth year and the tenth year, 100% of the initial cracks had reflected through the asphaltic overlay in all the test sections.

In general, the average amount of reflective cracking in the single and double strand GlasGrid® reinforced test sections was slightly less than that of the control sections over the first three years, indicating that the GlasGrid may have helped delay the development of reflective cracking. In any case, the difference between the sections was minimal. By the fourth year, the percentage of reflective cracks in the double strand GlasGrid® test sections surpassed that of the control sections and single strand sections.

The types of cracks that developed within the pavement test sections were also determined to be significant factors in the performance evaluation. As shown in Figure 3 on pages 15 and 16, the reflective cracks that developed in the control sections were predominantly transverse Type I single cracks (less than ½-inch in width), while the cracks in the GlasGrid® reinforced test sections were mainly transverse Type III banded cracks (multiple cracks in close proximity resulting in a narrow band of cracks). Type III banded cracks are more severe than Type I single cracks, are more costly to maintain, and typically have a greater negative impact on the overall service life of the pavement.

The banded cracks developed in the single strand and double strand GlasGrid® reinforced test sections within the first year, the severity of which increased over the years of the study. Over the first five years of the study, the band cracking in the single strand sections was tight with the cracks close together, while the band cracking in the double strand sections was more spread out. Over the remaining five years of the study, the banded cracks of the single strand sections widened and were comparable to those of the double strand section by the end of the study.

RESULTS

The GlasGrid® pavement reinforcement was unsuccessful in preventing reflective cracking, as cracks developed at the joints within six months. The crack survey results indicate that the GlasGrid® pavement reinforcement may have helped delay the development of some reflective cracking over the first three years. The percent reduction of reflective cracking, however, was minimal. By the fourth year, the double strand GlasGrid® test sections had the highest percentage of reflective cracking.

The sections with GlasGrid® reinforcement had more severe reflective cracking in the asphaltic overlay than the control sections with no pavement reinforcement at all. Both the single strand and double strand test sections exhibited mainly Type III banded cracks, while the control sections displayed primarily Type I single cracks.

Although the GlasGrid® pavement reinforcement slightly reduced the percentage of reflective cracking for the first three years, the cracking that developed over the GlasGrid® was more severe than that which developed in the control sections without reinforcement. Coupled with the increased project cost, it is concluded that GlasGrid® is not a cost-effective product for reducing or eliminating reflective cracking in asphaltic overlays placed on PCC pavements.

CONCLUSION

GlasGrid® is not effective in preventing or delaying reflective cracking in asphaltic concrete overlays caused by differential vertical deflection of adjacent slabs of the underlying pavement at transverse joints or cracks, which is a primary cause of reflective cracking in asphaltic concrete overlays. Thus, GlasGrid® pavement reinforcement is not a cost-effective product for combating reflective cracking in an asphaltic concrete overlay placed on a PCC pavement with “working” joints and cracks.

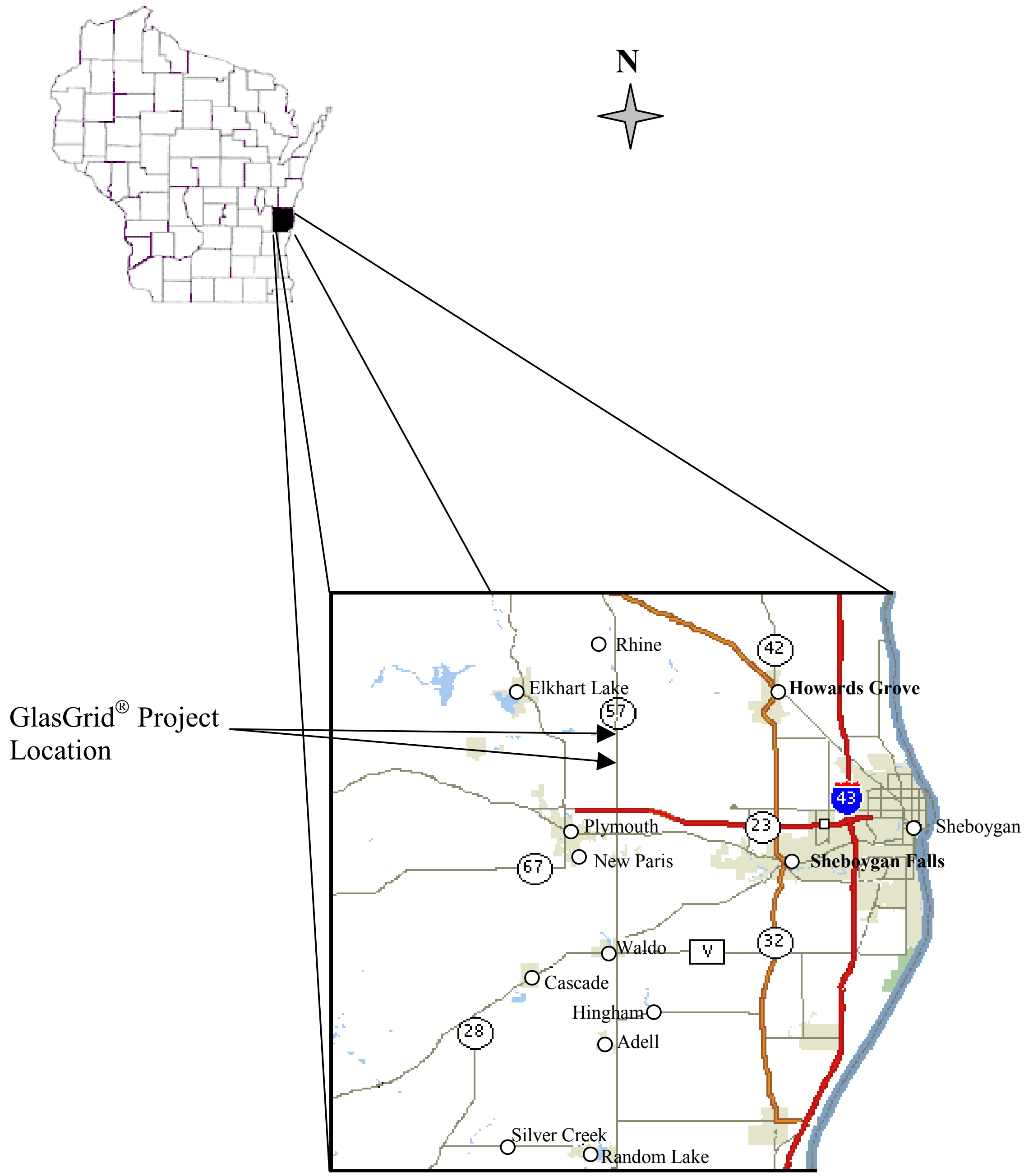
RECOMMENDATION

Based on the results of this study, it is recommended that WisDOT not use GlasGrid® fiberglass mesh reinforcement as a method of reducing reflective cracking of an asphaltic concrete overlay or for extending the life of an asphaltic concrete overlay placed on a PCC pavement.

Appendix

Figure 2. Study Test Section Location Map

GlasGrid® Pavement Reinforcement Study



Sheboygan County

Table 1a: *Number* of Cracks per Test Section

	1A - Double Strand		2A - Single Strand		1A - Control		1B - Double Strand		2B - Single Strand		1B - Control	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
Initial	33	28	30	31	27	28	30	30	30	34	33	31
1st year	18	16	19	17	17	18	17	13	17	15	15	19
2nd year	23	19	19	19	20	22	22	20	21	17	20	25
3rd year	27	20	20	22	22	24	24	21	23	20	24	25
4th year	30	25	22	27	23	24	28	23	26	25	29	27
5th year	31	27	24	28	23	24	28	24	26	25	29	28
10th year	35	32	32	32	28	29	33	31	34	34	36	32

Table 1b: *Percent* Reflective Cracking per Test Section

	1A - Double Strand		2A - Single Strand		1A - Control		1B - Double Strand		2B - Single Strand		1B - Control	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
Initial	**33**	**28**	**30**	**31**	**27**	**28**	**30**	**30**	**30**	**34**	**33**	**31**
1st year	54.5	57.1	63.3	54.8	63.0	64.3	56.7	43.3	56.7	44.1	45.5	61.3
2nd year	69.7	67.9	63.3	61.3	74.1	78.6	73.3	66.7	70.0	50.0	60.6	80.6
3rd year	81.8	71.4	66.7	71.0	81.5	85.7	80.0	70.0	76.7	58.8	72.7	80.6
4th year	90.9	89.3	73.3	87.1	85.2	85.7	93.3	76.7	86.7	73.5	87.9	87.1
5th year	93.9	96.4	80.0	90.3	85.2	85.7	93.3	80.0	86.7	73.5	87.9	90.3
10th year	106.1	114.3	106.7	103.2	103.7	103.6	110.0	103.3	113.3	100.0	109.1	103.2

Table 2a: % Reflective Cracking in NB Lanes per Test Section

% of Reflective Cracks in NB Lane						
	Year After Construction					
Section	**1**	**2**	**3**	**4**	**5**	**10**
Double Srand Test 1A	55	70	82	91	94	106
Single Strand Test 2A	63	63	67	73	80	107
Control 1A	63	74	82	85	85	104
Double Srand Test 1B	57	73	80	93	93	110
Single Strand Test 2B	57	70	77	87	87	113
Control 1B	46	61	73	88	88	109

Table 2b: % Reflective Cracking in SB Lanes per Test Section

% of Reflective Cracks in SB Lane						
	Year After Construction					
Section	**1**	**2**	**3**	**4**	**5**	**10**
Double Srand Test 1A	57	68	71	89	96	114
Single Strand Test 2A	55	61	71	87	90	103
Control 1A	64	79	86	86	86	104
Double Srand Test 1B	43	67	70	77	80	103
Single Strand Test 2B	44	50	59	74	74	100
Control 1B	61	81	81	87	90	103

Table 3a: Average % Reflective Cracking in NB Lane

Average % of Reflective Cracks in NB Lane						
	Year After Construction					
Section	**1**	**2**	**3**	**4**	**5**	**10**
Double Srand	56	72	81	92	94	108
Single Strand	60	67	72	80	83	110
Control	54	67	77	87	87	106

Table 3b: Average % Reflective Cracking in SB Lane

Average % of Reflective Cracks in SB Lane						
	Year After Construction					
Section	**1**	**2**	**3**	**4**	**5**	**10**
Double Srand	50	67	71	83	88	109
Single Strand	49	56	65	80	82	102
Control	63	80	83	86	88	103

Table 4: Average % Reflective Cracking per Test Section

Average % Reflective Cracking per Test Section						
	Year After Construction					
Section	**1**	**2**	**3**	**4**	**5**	**10**
Double Strand	53	69	76	88	91	108
Single Strand	55	61	68	80	83	106
Control	59	73	80	86	87	105

Figure 3. Cracking Photos

(a)

(b)

(c)

(d)

The photos above show Type III banded cracking in the single strand (a and b) and double strand (c and d) GlasGrid® pavement reinforcement test sections. Notice the multiple cracks in close proximity to the main crack.

Figure 3 (cont'd). Cracking Photos

(e)

(f)

The above photos (e and f) show Type 1 (< ½-inch) cracking in the control sections. This section does not have any reinforcement between the asphaltic concrete pavement layers. Notice the crack is less than ½-inch wide and has no other cracks within close proximity of it.